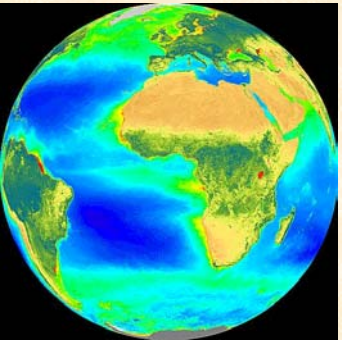
NOAA's Coral Reef Watch

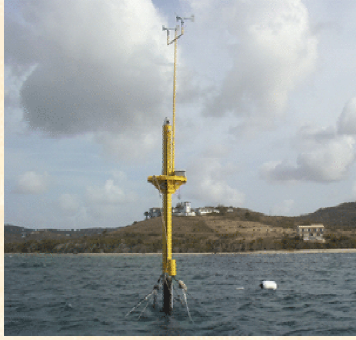
The Hydrodynamics of a Coral Bleaching Event:

The role of satellite and CREWS measurements.



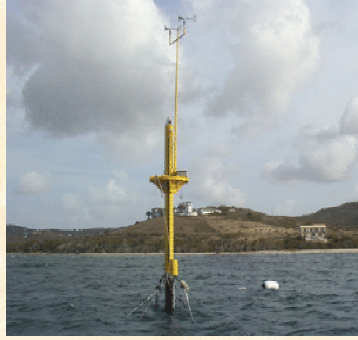
William Skirving

Overview



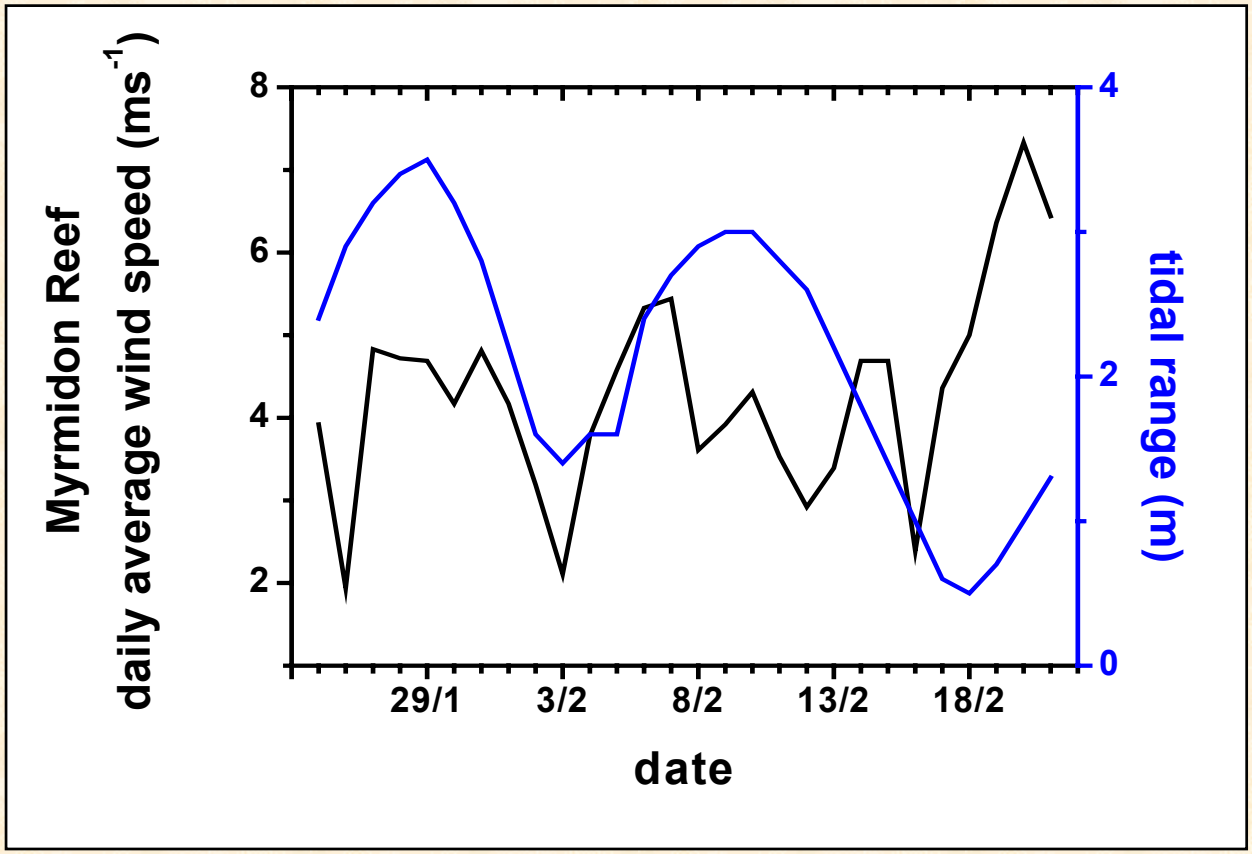
- **Bleaching weather**
  - Hydrodynamic Mixing
  - Why is mixing important
  - Mechanisms of mixing
  - LSI an example
- **The relationship between models, CREWS and satellite data**
- **Conclusion**

Bleaching weather

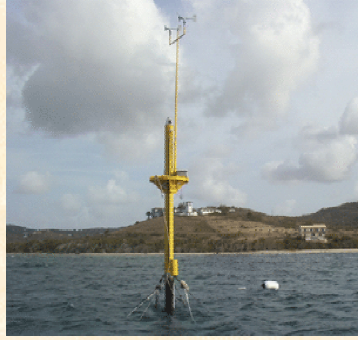


Myrmidon Reef daily average wind speed and maximum daily tidal range

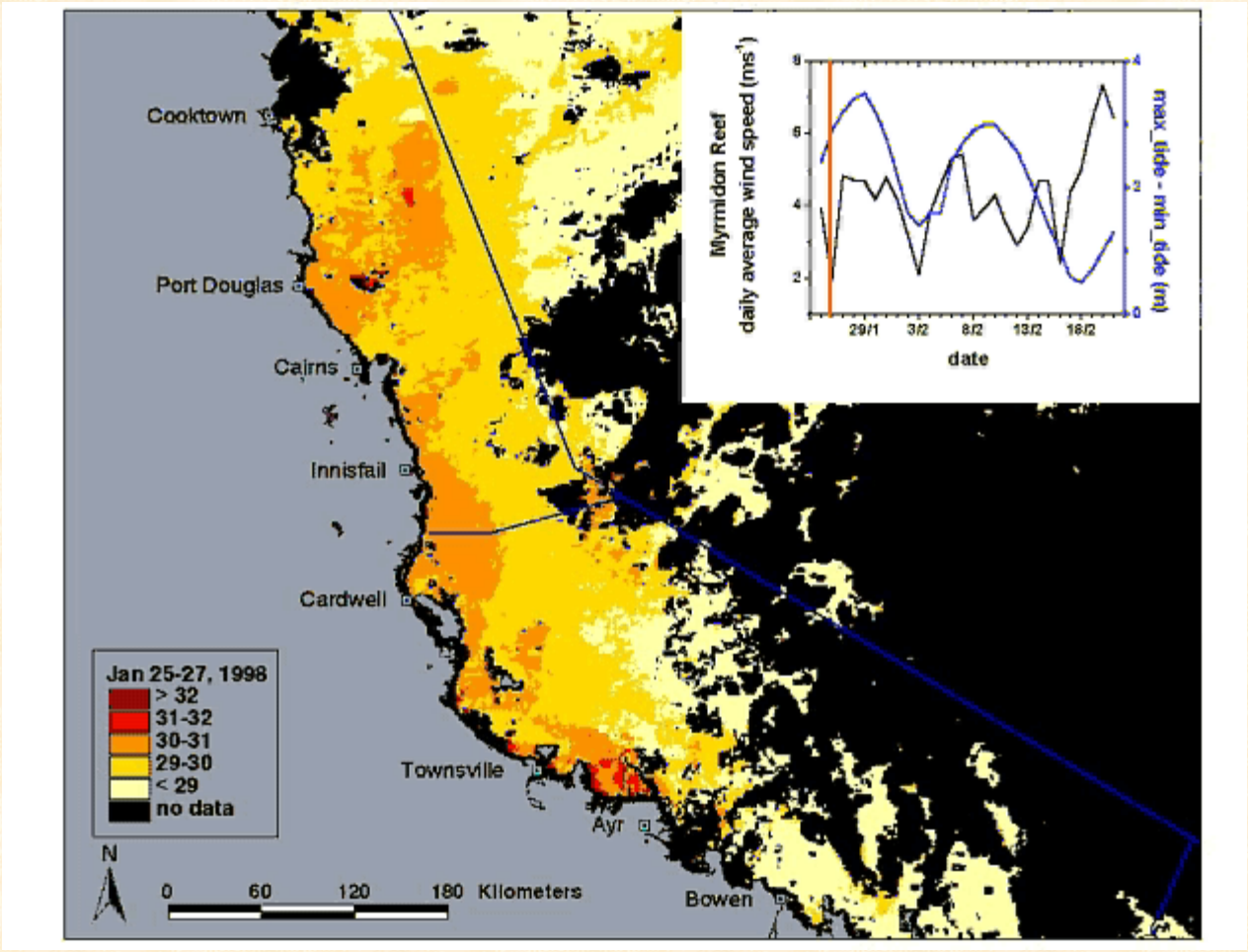
25th January to 21st February, 1998



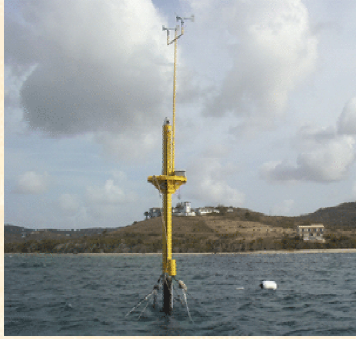
Bleaching weather



Animation of SST for 25th Jan to 21st Feb 1998

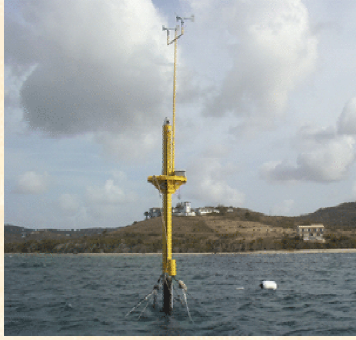


Bleaching weather

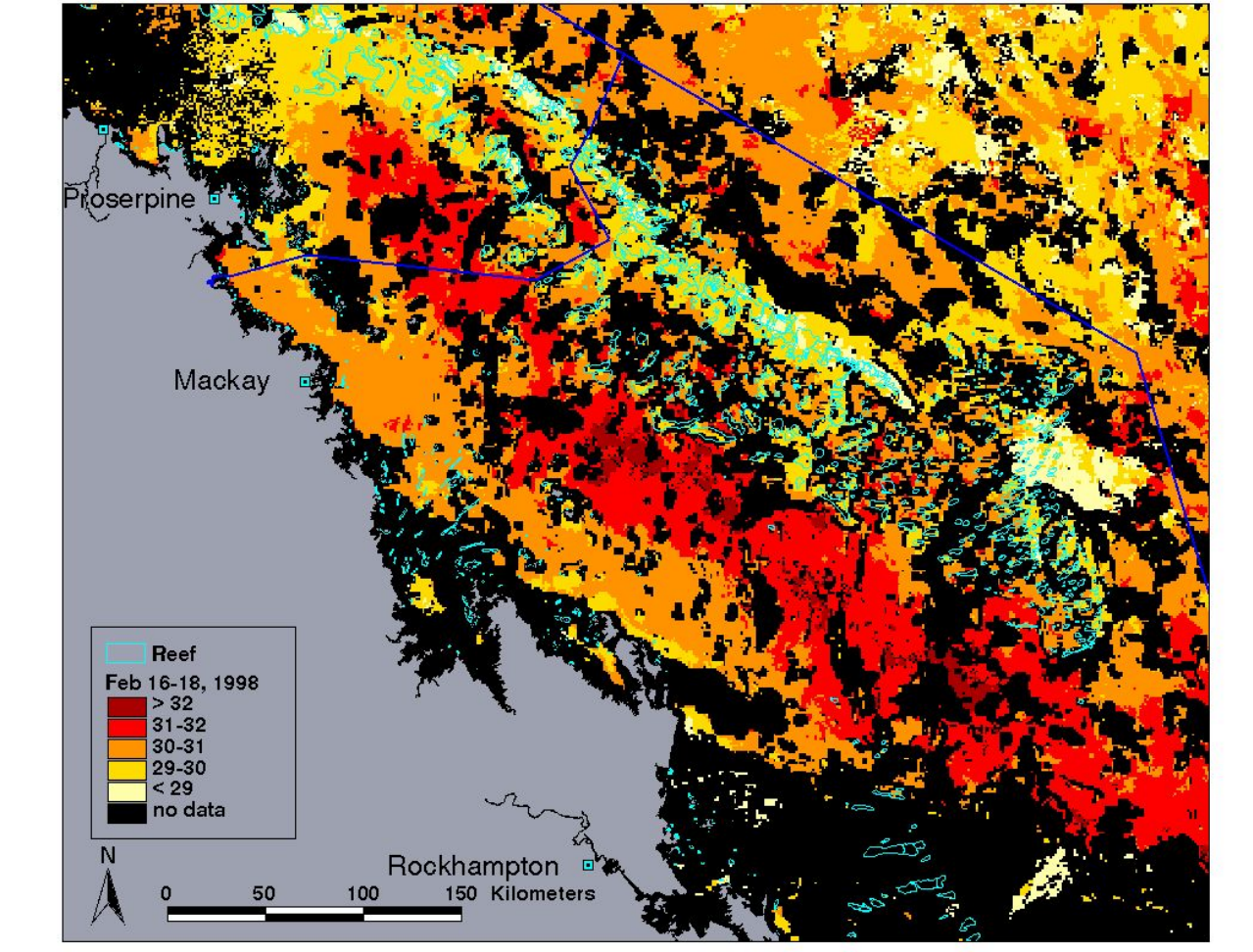


- Little to no wind
- Clear sunny skies
- Weak currents

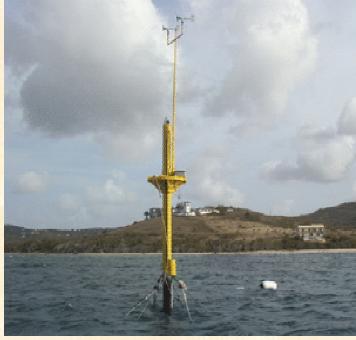
Hydrodynamic Mixing



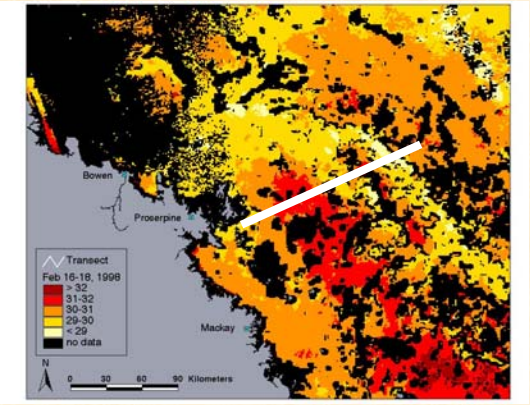
Southern GBR SST for 16th to 18th Feb 1998

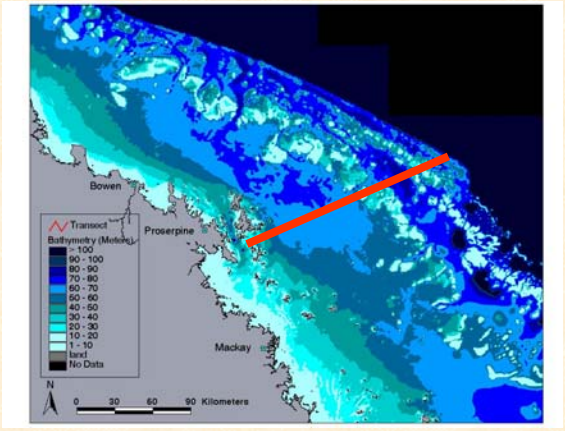


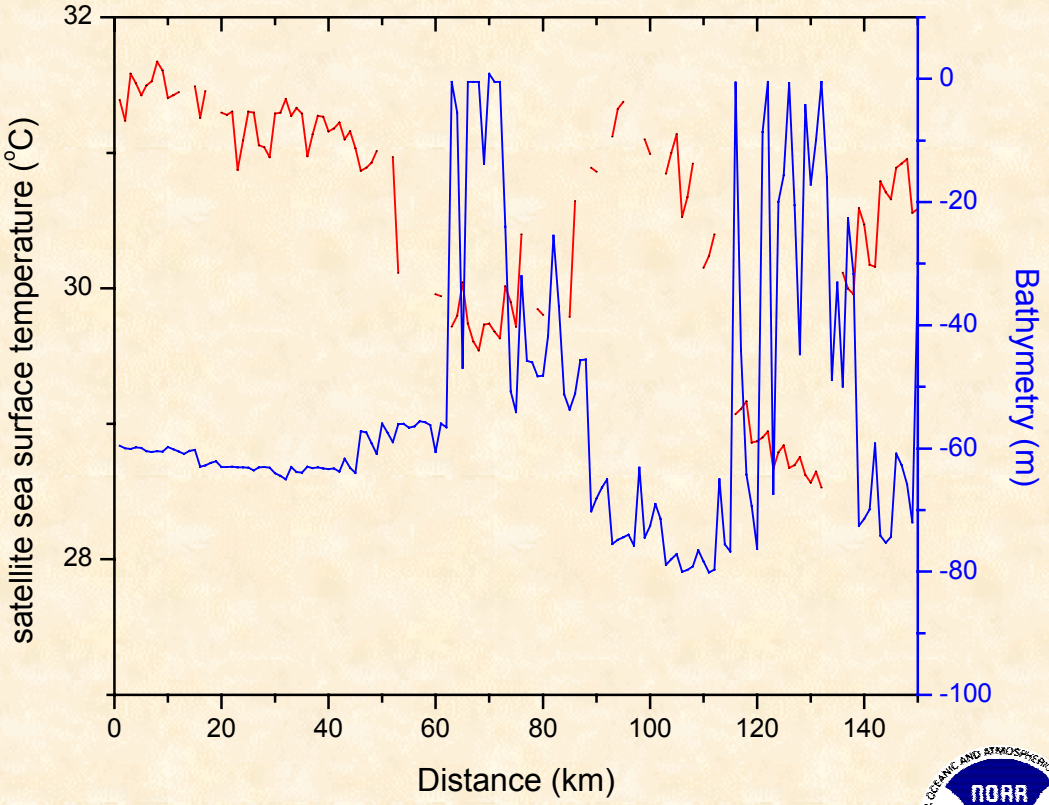
Hydrodynamic Mixing



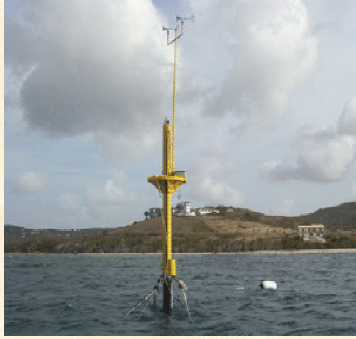
Southern GBR Temperature transect 16-18 February







Hydrodynamic Mixing

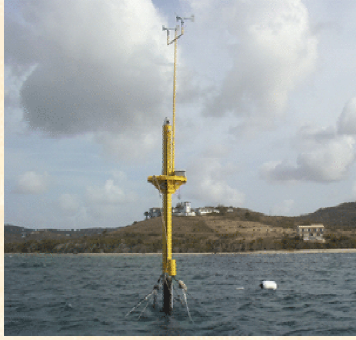


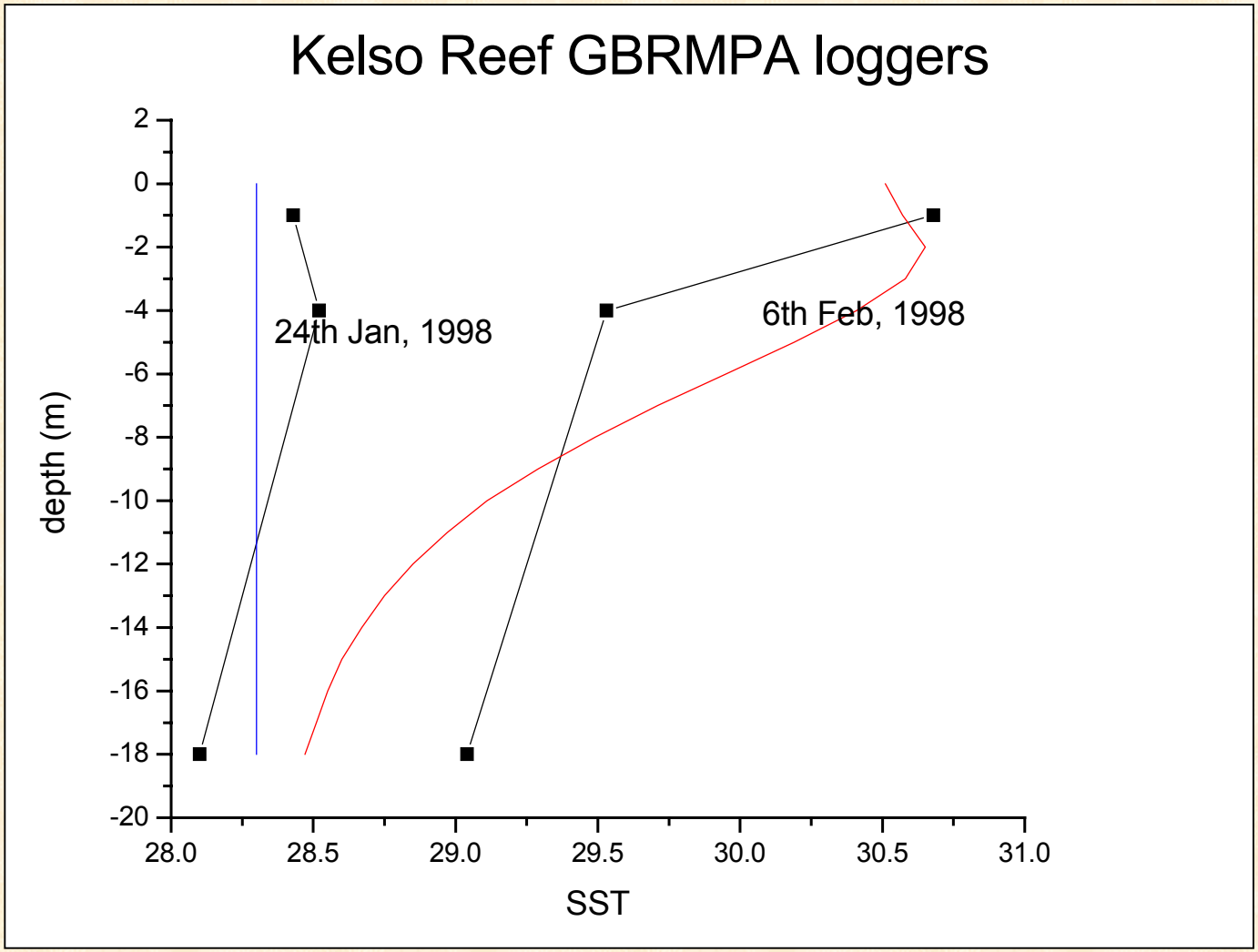
Mixing mechanisms:

- Wind
- Low frequency currents (eg East Australian Current, Gulf Stream)
- High frequency currents (tides)
- Swell waves

Why is mixing important?

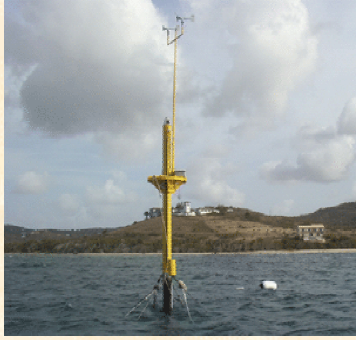
Vertical temperature profile

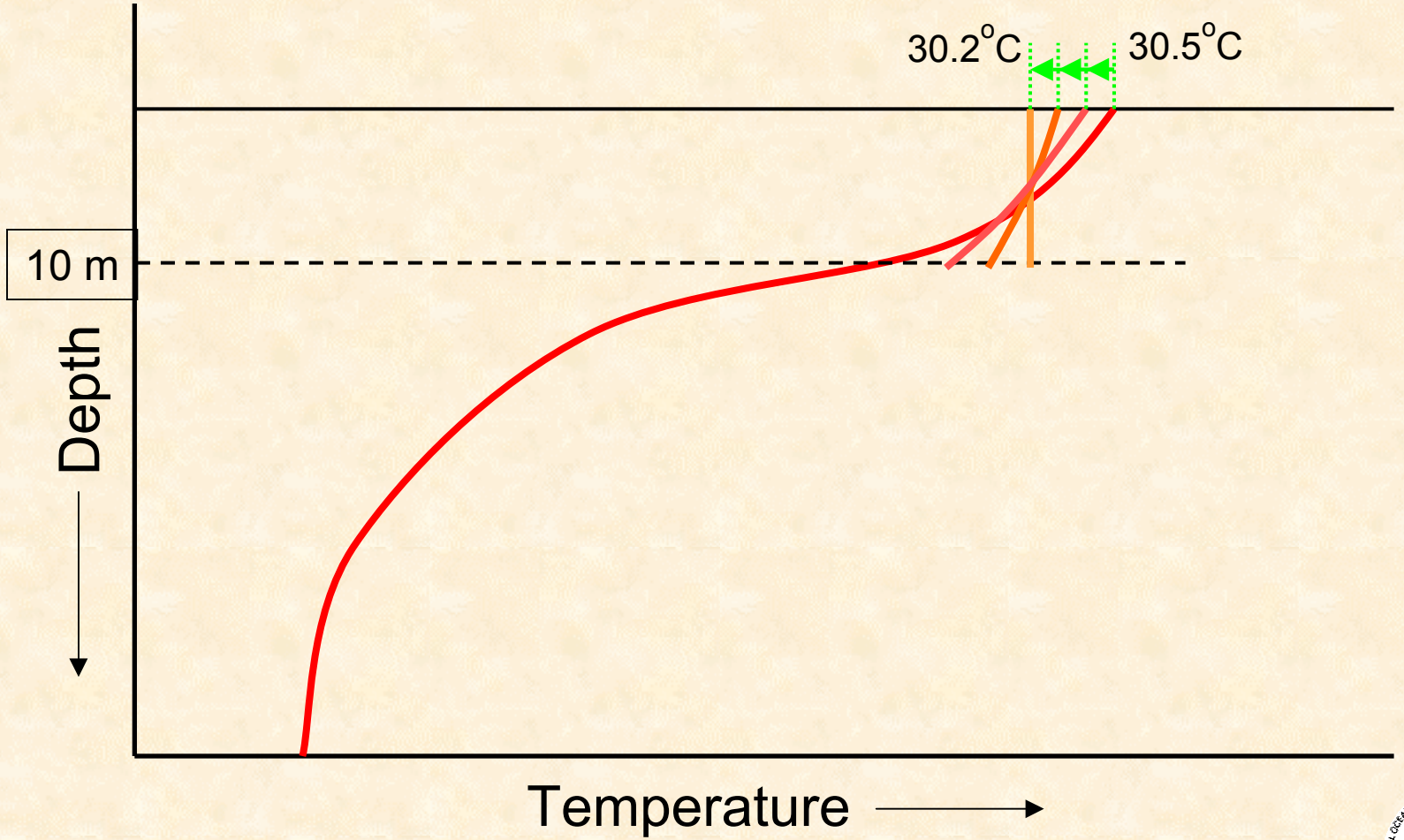




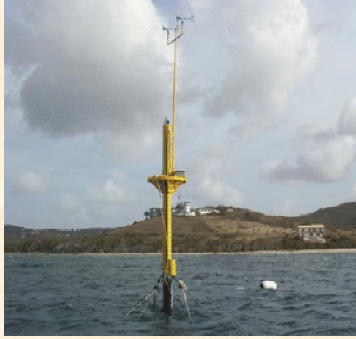
Why is mixing important?

Vertical temperature profile





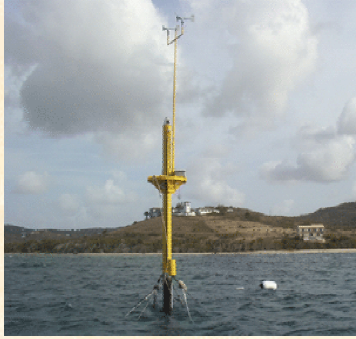
Hydrodynamic Mixing



Modeling SST during a bleaching event:

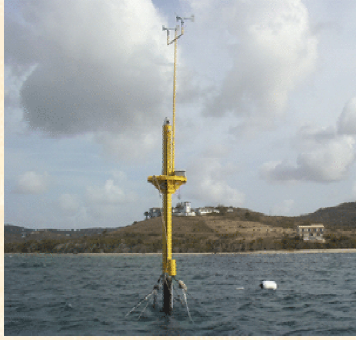
- Swell waves
- Low and High frequency currents

Modeling swell waves



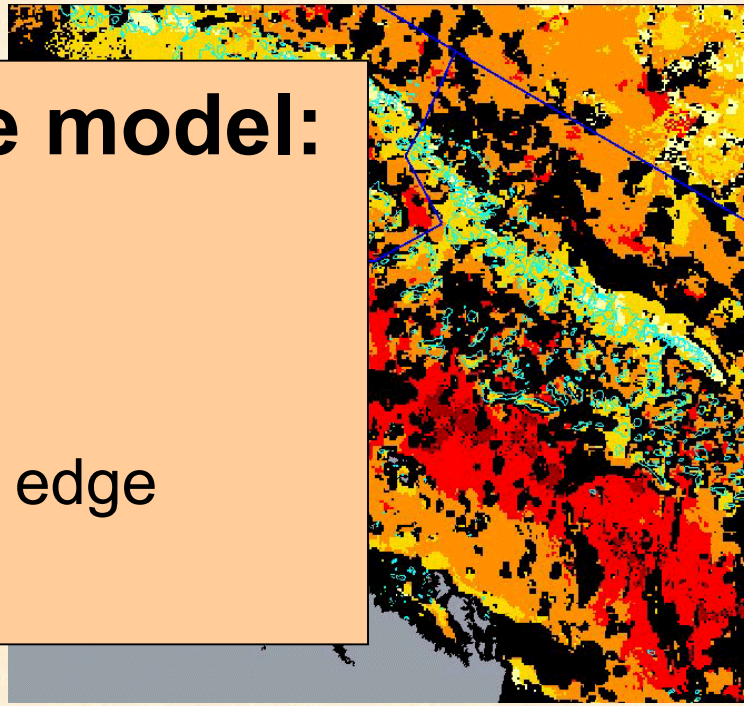
Preliminary research has shown that a 1m wave with a period of 8 seconds will mix to a depth of 50 metres in less than half a day. On average, this would translate to a surface temperature drop of 3 ^{o}C on the exposed side of an outer reef of the Great Barrier Reef during the 1998 bleaching.

Modeling currents for bleaching SSTs

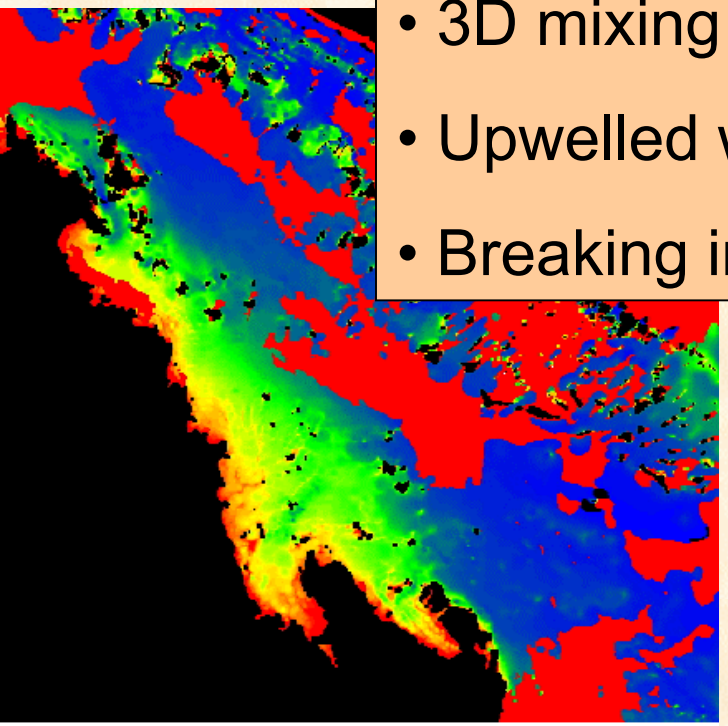


Omissions from the model:

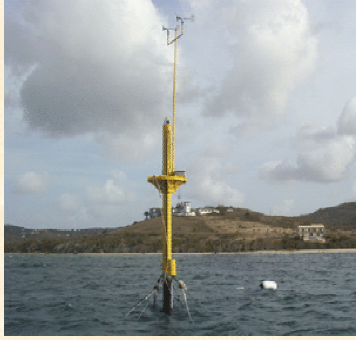
- Include advection
- 3D mixing behind reefs
- Upwelled water near shelf edge
- Breaking internal waves



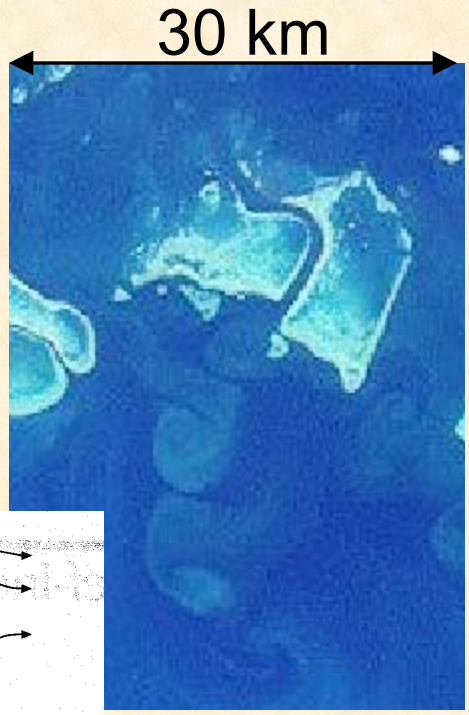
Satellite SST

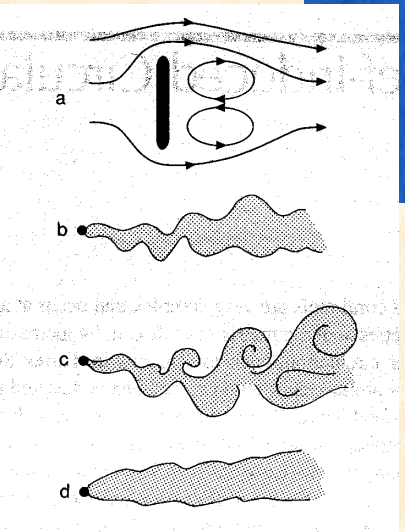


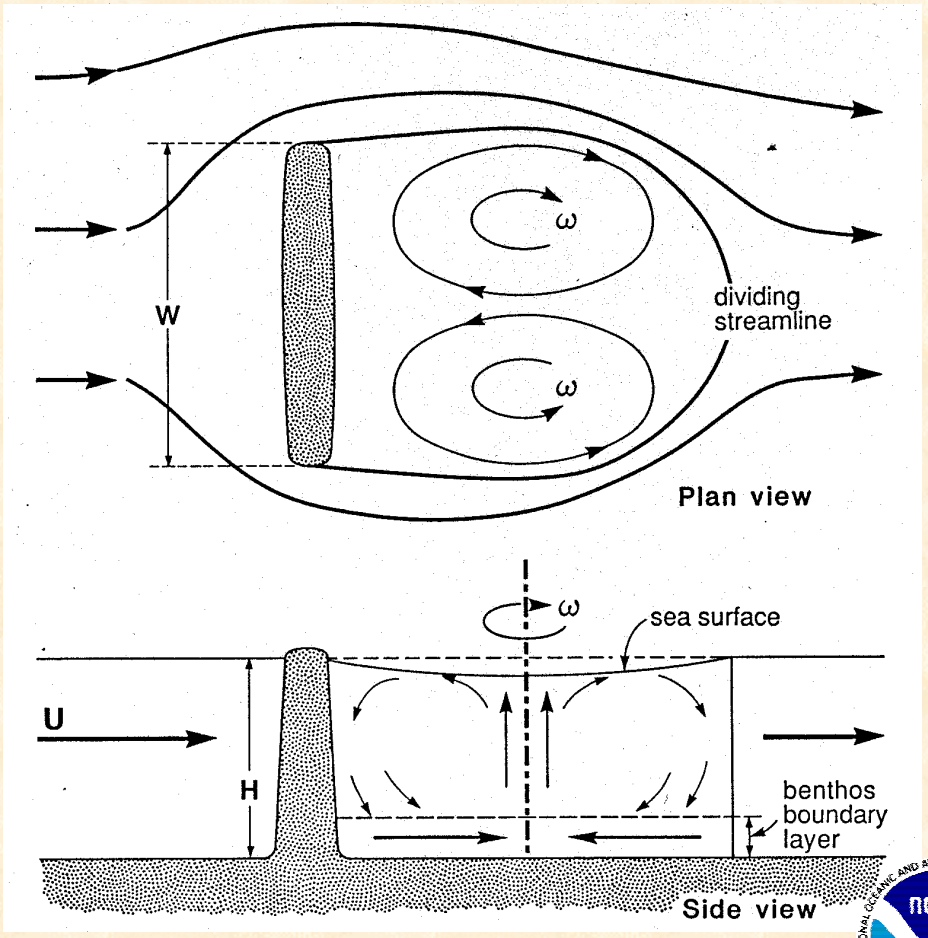
Reef induced mixing



Eddies in the lee of reefs

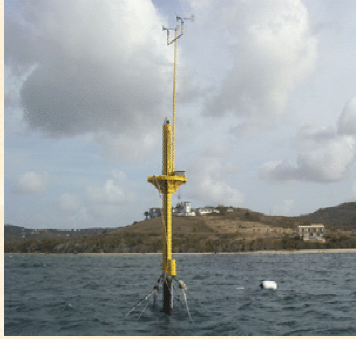






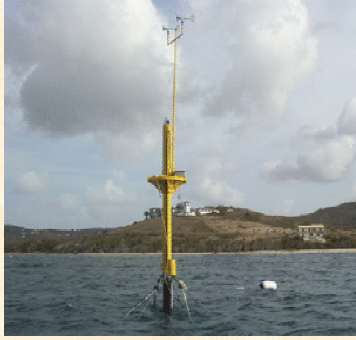
3D mixing behind reefs

Modeling bleaching SSTs

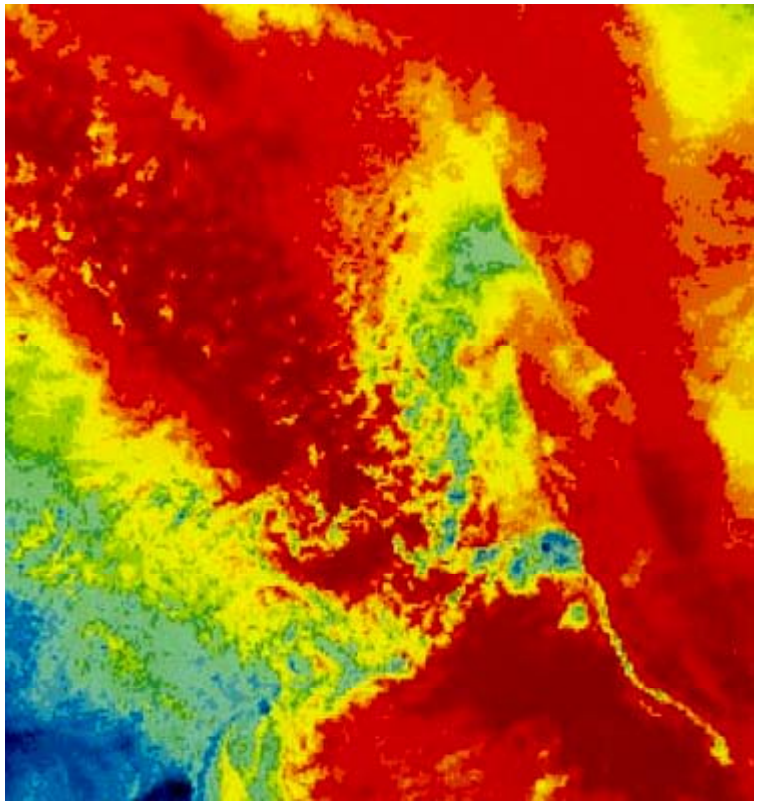


- Spatial patterns of SST are consistent from one severe bleaching to another
- SST can be modeled

Structure of SST in a Reef Matrix

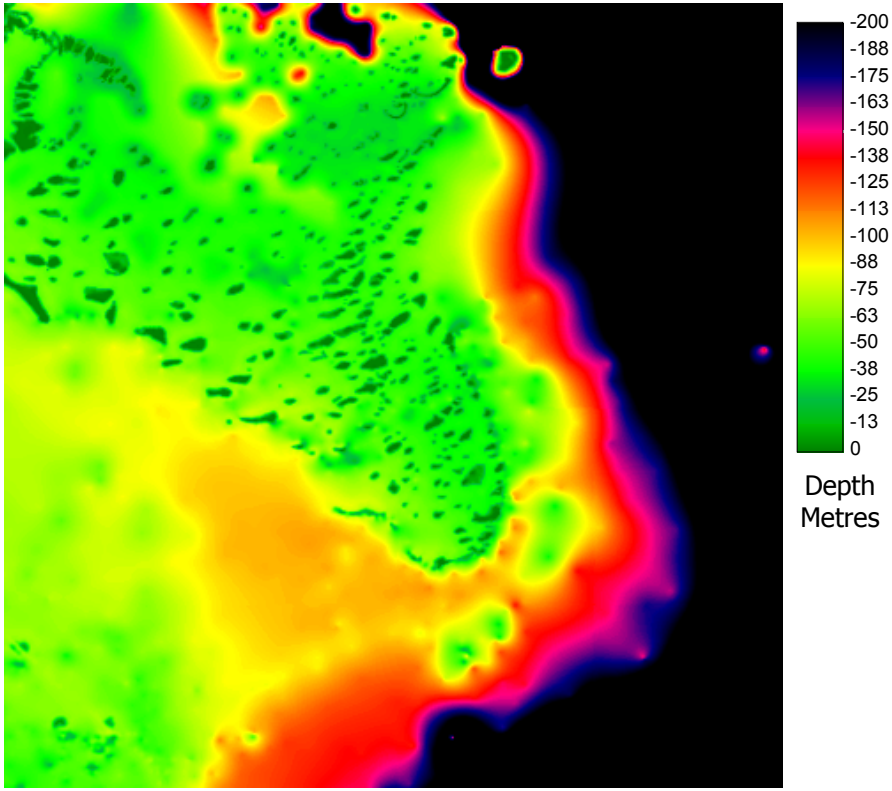


SST



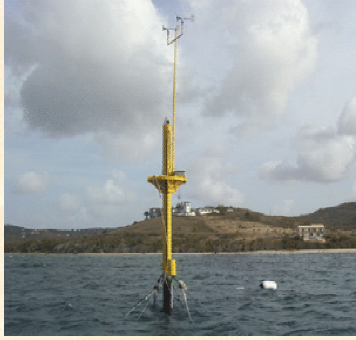
50 km

Bathymetry

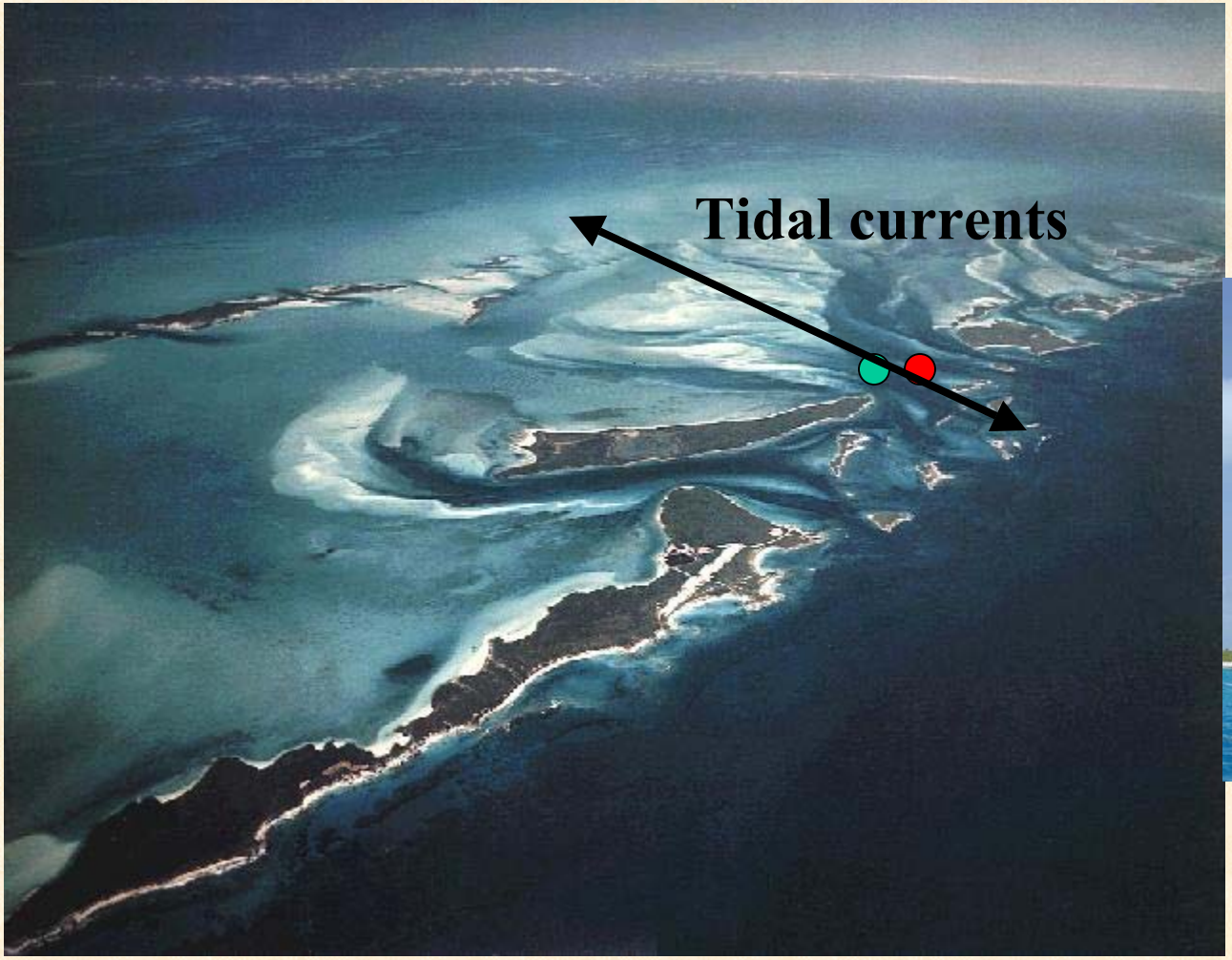


Southern GBR

Lee Stocking Island

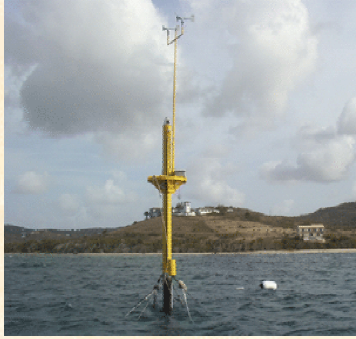


- Mast



- Buoy

Available data



CREWS data:

- Good temporal coverage
- 1D (measurements above and below water)
- Potentially very high accuracy
- Better range of measurements than satellites

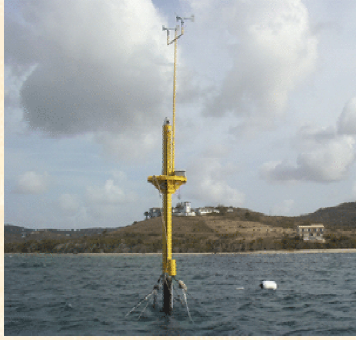
Satellite data:

- Not so good temporal coverage
- Effected by clouds
- 2D (very good spatial coverage)
- 1 to 4 km spatial resolution

Models:

- 3D
- Good temporal coverage
- Good spatial resolution
- can be used for “what if” scenarios
- Needs CREWS and satellites for nudging

Conclusion



- No single data source gives us the whole story
- Models are the only way of combining satellite and CREWS stations in a rigorous and meaningful manner
- Need more CREWS stations while we learn about bleaching and possibly less later, but we will **ALWAYS** need CREWS